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Ballistic Effectiveness of Water against a Shaped Charge Jet

by John Runyeon

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Three experiments were conducted to determine the ballistic effectiveness of water against a shaped charge jet. Water depths of 500, 1000 and 1500 mm were evaluated. The data suggest that water cannot be assigned one value to describe its ballistic efficiency against a shaped charge jet. Calculations show that 500 mm of water had an elemental mass efficiency (e_m) = 3.9, 1000 mm of water had an e_m = 2.6, and 1500 mm of water had an e_m = 1.8.

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1. Introduction, Experimental Setup, and Results

Three experiments were conducted on 28 June 2001 at the US Army Research Laboratory to determine the ballistic effectiveness of water against a shaped charge jet. The experimental setup is shown in Fig. 1. The shaped charge warhead used in these experiments had a 65-mm-diameter copper liner with a 44° cone angle. At 130-mm standoff, it nominally penetrated 380 mm of rolled homogeneous armor (RHA) steel. The wood boxes were lined with plastic and filled with fresh water that had been pumped from a local well. Figure 2 is a typical photograph of this procedure. Figure 3 is a photograph of a typical experimental setup. Figure 4 is a photograph of typical postexperiment debris. Table 1 summarizes the experimental results.

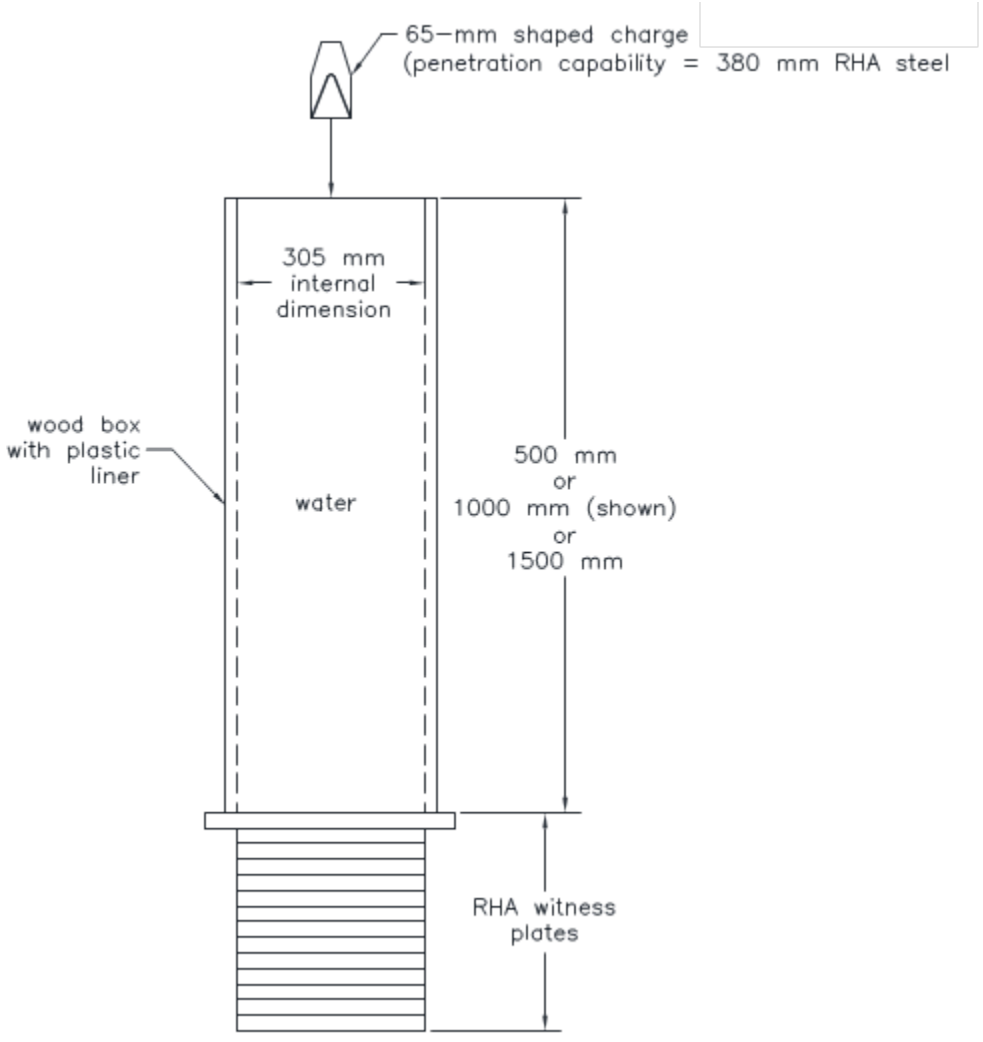

Fig. 1 Experimental setup

Fig. 2 Filling target with 500 mm of water

Fig. 3 Typical experimental setup. Target with 1000 mm of water is shown. The wood target assembly has a hole cut in the top so the first material impacted by the shaped charge jet is water.

Fig. 4 Typical postexperimental debris. Debris from target with 1000 mm of water is shown. The jet stopped in witness plate No. 3.

Table 1 Summary of experimental results

Depth of water (mm)	Penetration into RHA witness plate (mm)
0	380 (baseline data)
500	128
1000	56
1500	32

2. Discussion and Conclusion

At the standoff used in this experimental series, the 65-mm shaped charge has a nominal penetration capability of 380 mm into RHA steel. The first 500 mm of water decreased the penetration capability of the 65-mm shaped charge by approximately 250 mm. However, increasing the water in 500-mm increments showed decreasing effectiveness against the jet. Therefore, the data suggest that water cannot be assigned one value to describe its ballistic efficiency against a shaped charge jet.

Using data from Table 1500 mm of water had an elemental mass efficiency (e_m) = 3.9, 1000 mm of water had an e_m = 2.6, and 1500 mm of water had an e_m = 1.8.

Note that shaped charges have round-to-round variation and only one data point exists for each condition.

e_m calculations:

- e_m = (RHA penetration capability of the shaped charge minus residual penetration into RHA witness)/areal density of water expressed in terms of RHA equivalent.
- For the experiment with 500 mm of water, 500 mm of water has the equivalent areal density of 64 mm of RHA steel. Therefore, e_m = (380-mm RHA penetration capability minus 128-mm RHA residual penetration)/64-mm RHA equivalent = 252/64 = 3.9.
- For the experiment with 1000 mm of water, e_m = (380-mm RHA penetration capability minus 56-mm RHA residual penetration)/127-mm RHA equivalent = 324/127 = 2.6.
- For the experiment with 1500 mm of water, e_m = (380 mm RHA penetration capability minus 32-mm RHA residual penetration)/191-mm RHA equivalent = 348/191 = 1.8.

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